APPLICATION

FOR

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FOR

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FOR

MODULE FOR LIGHTED GARMENTS, SHOES OR ACCESSORIES

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BACKGROUND OF THE INVENTION

The present invention relates to wearing apparel, to footwear, to other garments, and to accessories, such as backpacks, worn with lighting elements. Footwear and garments with flashing lights have been popular for a number of reasons, including safety, an attractive appearance, and simply for a novelty effect.

Lighting units for footwear have typically included a light source, such as one or more light-emitting diodes, a power source, such as a battery, and a switch to cause the power source to be connected to the light or lights. Often such units will include electronic circuit modules which can control the time such lights are actually illuminated, which limits the power consumption, saving the battery. Characteristically, electronic circuits have used lead or lead/tin solder in many components and joints. From 1992 to present, all children's lighted shoes contain lead. A search of the art discloses by this invention no attempt to remove lead (Pb) from shoes.

There has been a considerable effort to minimize or remove lead from the environment, and particularly from children's rooms and toys. In carrying out this effort, it is desirable to provide lighting modules for shoes and other garments that are lead free (Pb). As such lighting circuit modules become more popular, they are often incorporated into garments, especially shoes for children. The modules that are concealed in shoes are usually glued or cemented into the heels and are generally inaccessible, but as these shoes find their way into landfills, the toxic lead can possibly leach out causing contamination of the environment. Other modules and associated wiring, which may be in jackets, shirts, or backpacks, also include a number of solder

joints that contain lead. While larger electronic components are seldom relegated to landfills, worn out clothing and shoes, often is.

Children's electronically lighted shoes, in particular, are not recyclable and, when worn out or outgrown, typically end up on landfills. The accumulation over time of many millions of shoes with modules containing lead carries a risk of the lead getting into ground water, thereby polluting drinking water sources. It is desirable that this possible source of contamination be eliminated. It is believed that it is only of question of time before any electronic assemblies containing lead-based solder will be legislatively banned from landfills.

BRIEF SUMMARY OF THE INVENTION

To avoid exposing children or others and the environment to contact with lead, the applicant has devised an electronic module for illuminating lamps used in shoes or other clothing or accessories wherein the normally soldered electrical connections are replaced with non-soldered connections, including mechanical spring clamps or clips and pressure pads. Such pads may include a non-conductive foam sandwich to hold wires in contact with conductive traces on circuit boards.

Principal components of such a module include:

a) a circuit board having a number of conductor "printed circuit" traces;

b) one or more lamps and wires from the circuit board to the lamps;

c) a battery connected to the circuit board for powering the lamps;

d) a switch for turning the lamp or lamps on and off;

e) leads from LEDs or lamps connected to wires;

f) spring connectors, mechanical clamps, foam clamp pads, crimping connections; and

g) shrinkable non-conductive material for encapsulating the module;

The battery is typically in the form of a coin size cell, lithium wafer in which opposite sides are of opposite polarity.

A switch, which may be an inertia switch, is generally elongated and has a terminal at each end. Spring clamps connect the terminals to conductor tracks on the circuit board and also mechanically connect and secure the switch to the circuit board.

Contacts on the circuit board are connected with conductor tracks and spring

clamps mechanically and electrically secure wires from the lamp or lamps to the conductor tracks. From the foregoing, it will be recognized that spring clamps secure electrical connections:

a) between the battery and conductor traces on the circuit board in addition to mechanically securing the battery to the circuit board;

b) between the switch and conductor traces on the circuit board in addition to mechanically attaching the switch to the circuit boards; and

c) between the lamps and connecting wires and from connecting wires to the circuit board.

In one embodiment, a first spring clamp mechanically secures the battery to the circuit board and electrically connects one side of the battery to one of the conductor tracks. Another spring clamp connects the other side of the battery to another conductor track.

The entire assembly is enclosed in a plastic encasement, potted or covered with a conformal coating which is in intimate contact with the joints as well as the components.

In another embodiment, all or part of the wires from the switch, from the lamp or from other components are clamped against tracks on a circuit board by pressure from a resilient, non-conductive pad, such as polyfoam, which is held against the circuit board by means of a hard, non-flexible layer or plate which may be held by spring clamps or by screws passing through the circuit board and the plate. The exterior encasement, potting or conformal coating upon curing shrinks and applies pressure to the pressure pad, which maintains electrical connections under the pad.

It is possible to produce a lighting circuit for shoes and other garments and accessories which employs no circuit board at all. A simplified such circuit is described below.

The above-described assembly is then preferably encased in potting compound. Such potting compound encapsulation or conformal coating must be compatible with the resilient pad and non-corrosive of any component of metallic materials and joints.

With all the electrical and mechanical connections completed as described, the module is then encapsulated in potting compound which shrinks as it cures effectively providing a compressional force due to the resin shrinking from curing which maintains the connections in spite of the physical abuse to which children's shoes and other lighted garments may be exposed.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention may be more clearly understood with the following detailed description and by reference to the drawings in which:

Fig. 1 is a perspective view of a shoe, shown in phantom, with a prior art lighting system;

Fig. 1A is a plan view of a lighting system incorporating this invention, including encapsulation in a potting compound;

Fig. 2 is a front view of an individual wearing a shirt or jacket, including flexible lighting strips and employing the lead free module in the lighting system of this invention;

Fig. 3 is an enlarged fragmentary view of the encircled portion of Fig. 2 designated with a numeral 3;

Fig. 4 is an enlarged plan view of a lighting module incorporating my invention;

Fig. 5 is an enlarged bottom view of the lighting module of Fig. 4;

Fig. 6 is an enlarged side elevational view of the module of Figs. 4 and 5;

Fig. 7 is an enlarged view of an alternate spring clip for lead free attaching lamp wires to the lighting module of the invention;

Fig. 8 is an enlarged perspective view of the battery clip forming part of the module of Figs. 4 and 5;

Fig. 9 is a perspective view of a switch with spring clips attaching the switch to the module of Figs. 4 and 5;

Fig. 10 is a bottom perspective view of another embodiment of the module

according to the invention;

Fig. 11 is an exploded view of the module of Fig. 10; and

Fig. 12 is a partially exploded drawing of a simplified lighting circuit for shoes and other garments and accessories in which no circuit board is employed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Fig. 1, a shoe **10** is shown having a prior art lighting system, electrical circuit board **12**, including a battery **14** and a switch **16** in its heel. Connected to the electrical circuit board **12** are pairs of wires **18**, **20**, and **22** terminating in light sources, such as LEDs **24**, **26**, and **28**, respectively, which are located in the shoe **10** such that they are readily visible and will attract attention of those nearby.

Fig. 1A is a perspective view showing a lighting system of the invention as encapsulated in a potting compound. Within the normally transparent encapsulation layer **15** are shown electrical components, such as a circuit board **12**, a battery **14**, and a switch **16**. Conductors **20** and **22** ~~**21**~~ connect lamps or LEDs **27** and **29** of Fig. 1 to the system. Encapsulation of the system protects not only the components, but the connections as described below.

Fig. 2 is a front view of an individual **30** wearing an article of clothing, specifically a shirt or jacket **32** having light-transmitting strips **34** and **36**, preferably of plasticized polyvinyl chloride (PVC), secured to its sleeves. Details of this garment and lighting strips are described in greater detail in U.S. Patent 5,649,755 of this inventor. Light-transmitting strips **34** and **36** are illuminated by lamps or LEDs connected to a circuit board **12** or a similar board, including a switch **16** or a switch **74**, as shown in Figs. 1 and 2 or Figs. 4-6, respectively. Upon movement of the individual wearing the shirt of jacket **32**, switch **16** will close the circuit on circuit board **12** causing illumination of the lamps or LEDs **61** and **62**, which causes light to travel through strips **34** and **36**.

Fig. 3 is an enlarged view of the encircled portion **3** of Fig. 2. The sleeve of

jacket **32** includes light-transmitting strips **34** and **36** ends of which are in close proximity to LEDs **61** and **62**. LEDs **61** and **62** are connected to circuit board **12** such that movement of the individual **30**, and particularly of his arms, will cause momentary closure of switch **16** resulting in illuminating of LEDs **61** and **62**. This momentary illumination of the LEDs will cause light-transmitting strips **34** and **36** to be illuminated also. The lighting system of Fig. 3 would typically be encased in potting material which has been deleted for clarity.

Fig. 4 is an enlarged plan view of a lighting module incorporating my invention. A circuit board **50** includes an integrated circuit **52** connected through conductive traces $\mathbf{T_1}$ and $\mathbf{T_2}$ on the circuit board to terminals **54**, **56**, each of which are connected to one conductor of a double conductor wire **58**. Wire **58** is connected with non-lead spring clamp fasteners **60**, **60'** to an LED or lamp **62**. The opposite end of wire **58** is connected to terminals **54**, **56** by means of fasteners similar to spring clamp fasteners **60**, **60'** or other non-lead crimped fasteners. Fasteners securing leads from wire **58** have not been shown to avoid obscuring connections from wire **58** to terminals **54** and **56** on printed circuit board 50. Because of the close proximity of metal fasteners **60**, **60'** and of other fasteners described herein, it may be necessary to provide insulating tubing over the bare wire ends of an LED or lamp **62** to avoid short circuits.

A battery **64**, largely concealed by circuit board **50** in Fig. 4, is held against the lower side of circuit board **50** by means of a spring clamp **66** having an arm **68** contacting a trace $\mathbf{T_4}$ on the top of circuit board **50** and another lower arm **70** (not visible in this view but appearing in Fig. 5) contacting one side (+terminal) of the battery **64**. A smaller spring clamp **72**, extending through a notch **51** of the circuit board, contacts the

upper or opposite side (-terminal)) of the battery and connects it to track or trace T_1 on the top of circuit board **50**. A switch **74** having spring clamps **76** and **78** is shown spaced from circuit board **50** and contact pads or traces T_5 and T_6. Clamps **76** and **78** are normally clamped to contact pads or traces T_5 and T_6 on circuit board **50** as indicated by the dashed lines.

Fig. 5 is an enlarged bottom view of the lighting module of Fig. 4. Visible in this view are battery **64**, circuit board **50**, spring clamp **66** including lower arm **70**, lamp lead wires **58**, spring clamps **60** and **60'**, lamp **62**, and switch **74** with spring clamps **76** and **78** (exploded from the board **50**).

Fig. 6 is a side elevational view of the module of Figs. 4 and 5 after encapsulation with part of the encapsulation broken away to show the interior. Note that the battery **64** is mechanically clamped to the bottom of circuit board **50** by means of the spring clamp **66** and provides an electrical connection between the positive side of battery **64** and a conductor trace or track T_3 (Fig. 4) on circuit board **50**. The separate small clamp **72** contacts the negative side of battery **64** and passes through notch **51** (Fig. 4) providing an electrical connection to another conducting trace T_4 on the face of circuit board **50**. The switch **74** is visible on the back side of circuit board **50** and battery **64**. When the module is assembled as described, it is encapsulated in potting compound **75**. Once the potting resin cures, it will shrink approximately 6% creating a compressional force on all connections inside, enhancing reliability.

Fig. 7 shows an alternative structure for mechanically and electrically connecting wires **58** to circuit board **50**. A generally "S" shaped spring clip **80** includes an arm **82** extending below circuit board **50**, another arm **84** extending across the top of circuit

board **50** and contacting a conductor trace **86**, and a further doubled back arm **88** which includes a loop **90** to which one of wires **58** is crimped. An identical spring clip could be used to connect the second conductor wire of **58** to a second trace similar to trace **86**.

Fig. 8 is a perspective view of the spring clamp **66** which is generally U-shaped with a shorter arm **68** and a longer arm **70**. Spring clamp **66** will necessarily be quite stiff to secure battery **64** and circuit board **50** together. Clamp **66** is of a suitable metal, such as spring steel, brass or bronze, and is electrically conductive. Clamp **72** (Fig. 9) is also of spring material and is similarly conductive.

Fig. 9 shows switch 74 with clamps 76 and 78 extending through the sidewall of switch 74 to serve as contacts. Switch 74 is preferably the free rod in a closed tube-type switch of my co-pending application Serial No. _________ filed January 27, 2004.

Clamps **76** and **78** of Figs. 4 and 5 are as shown in Fig. 9. The lengths and widths of the arms in any of the described clamps can be varied to suit requirements. Spring hardness can be applied to the section used as a spring clamp only, as to allow crimping when necessary.

Fig. 10 is a bottom perspective view of another embodiment of the invention prior to encasement or encapsulation. A circuit board **100** includes a plurality of holes **102**, **103**, **104**, **105**, **106**, and **108** therethrough which communicate with electrical contacts each connected to a conductor track on the top side of the circuit board **100** (unshown). Lamp wires **114**, **116**, and **118** are fed through holes **102**, **103**, **104**, **105**, **106**, and **108**, respectively, and bent over to make contact with the desired conductor traces **T** (unshown) on the upper side of the board **100**.

A resistor **120** is positioned on the lower side of the circuit board **100** and

includes leads which pass through ports **122** and **124**, and which are then crimped over to make contact with conductor traces **T** or tracks on the top side of circuit board **100**. Other components may be located on the top of circuit board **100**. Their leads are extended along the tops of the desired conductor traces **T** and are pressed down on the conductor traces **T** by means of a polyfoam pad **126**, which is non-conductive and which is somewhat thicker than the height of any component on the top side of the circuit board **100**. Pad **126** may have cut-outs to conform to components. A preferred material for pad **126** is a resilient, non-conductive polyfoam, such as polyurethane foam.

Pad **126** is then pressed tightly against circuit board **100** and any components or leads thereon by means of a hard, non-flexible board **130** that may be fastened to the circuit board by means of screws **128** or other suitable mechanical clamping devices.

Fig. 11 is a side view, partially exploded, of a module similar to that of Fig. 10. In this view, the circuit board **100** has a series of holes or bores at one end for receiving wires from the lamps. A bore **B** is visible that receives a wire **108** which is crimped against a conductor trace **T** on circuit board **100**. A wire **132** from a switch **134** is fed through another bore **136** and crimped over against a conductor trace **T** on the **upper** surface of circuit board **100**.

A resistor **138** is mounted on the lower side of the circuit board and has leads **140**, **142** which are fed through bores **144** and **146**, respectively, and are crimped over against conductor traces **T** on the surface of circuit board **100**. A capacitor **148** has leads **150** and **152** which are aligned with conductor traces **T**. Another component **154**, which may be an integrated circuit or surface mount device, also has leads **156**, **158**, which are aligned along conductor traces **T** on the surface of circuit board **100**.

Placement and alignment can also be accomplished with a resilient, non-conductor polyfoam pad that has been molded, tooled or carved out with cavities that hold electronic components in precise alignment with PCB (Printed Circuit Board) traces **T**, then clamped down for electrical connection as described below to facilitate assembly.

Placed over the top of circuit board **100** and the various leads and components located thereon is a resilient, non-conductive polyfoam pad **160** of somewhat greater thickness than the height of any component on the top surface of circuit board **100**. Overlaying pad **160** is a hard, non-flexible board **162** serving as a clamp to clamp pad **160** hard against the top surface circuit board **100**, thereby forcing all of the several leads tightly against their respective conductor traces **T** and thereby effecting electrical connections between the respective leads and conductor traces **T**.

A convenient way of providing such clamping force is by means of screws **128** passing through the circuit board **100** and board **162**. Other mechanical arrangements may be used and may be advantageous for modules of a somewhat different construction. It is contemplated that some construction may be best effected by a combination of the above described spring clamps and the resilient pad and such pressure-applying means as a hard backing board.

Once the circuit module is assembled as described above, it will typically be potted to hold all parts in position and further secure all electrical connections since the shoes, garments, or accessories described must be designed to withstand much physical abuse.

Fig. 12 is a partially exploded drawing of a simplified lighting circuit for shoes and other garments and accessories in which no circuit board is employed. A switch **164**

which is, or may be, the same as switch **74** (Fig. 9) has exterior contacts which may be spring or pad clamps **166**, **168** mated to plugs **170**, **172** clamped or crimped to insulated wires **174, 176**. The opposite end of wire **174** is stripped and placed against one side of a battery **180** which may be a disk-type battery, such as battery **14**. Placed against the opposite side of battery **180** is a stripped end of an insulated wire **182**. The opposite ends of wires **182** and **176** are crimped or clamped to wires **186** and **184**, respectively, which are crimped or clamped to leads **188** and **190** from a lamp or LED **192**.

Shown spaced from wires **174** and **182** are polyfoam insulating pads **194** and **196**. Adjacent pads **194** and **196** are hard boards or clamps **198** and **200**, respectively. A screw **202** is shown passing through boards **198** and **200** and polyfoam pads **194** and **196**. This screw and preferably at least one other such screw are tightened down to clamp polyfoam pads **194** and **196** securely against the stripped ends of wires **174** and **182** assuring their contact, both electrical and mechanical, with battery **180**.

As in other systems described above, quick movement of switch **164** will close the switch contacts connecting battery **180** to LED **192**. All electrical connections are accomplished by clamping or crimping or by means of the friction of plug in sockets and no solder is used or required anywhere in the system.

The term "potting" as used herein refers to a form of protective encapsulation which is effective to prevent moisture entering the protected module which could damage it and prevent its operation. The potting also provides mechanical protection against any outside contact. The module is normally enclosed in fabric, either in a shoe or on the clothing, but is still subject to possible damage in use. The potting then provides an effective skin of substantial thickness, e.g., 1/16 to 1/8 of an inch, around

the module. This is illustrated in Fig. 1A which shows a completed system with only insulated wires extending out of the module.

The preferred encapsulating material is polyester resin. Epoxies and thermal set plastics may also be used. Each of these materials has a property of shrinking upon curing or cooling, producing a compressional force on all connections resulting in a more reliable circuit. In order to be assured that the potting step itself does not damage or interfere with the reliability of any of the mechanical/electrical connections, it was determined that a test program was necessary. Now with the elimination of solder, it is essential that all mechanical/electrical connections, either by spring force, crimping, swedging, or clamping in accordance with this invention, remain effective. A number of tests were conducted to determine the reliability of the connections.

I have taken test samples of various connections with wire leads exposed with their mechanical connection, measured resistance and found virtually zero resistance through each of those joints after assembly. I have then subjected them to potting with the preferred form of potting compound, namely, casting resin and have taken measurements of resistance across the joints shortly after the potting compound was applied and found no change in resistance. I again measured the resistance across each of the joints upon final curing of the potting compound and again found no change in resistance across the connections.

The module was also subjected to outside temperatures, ranging from below freezing to very hot (30°F. to 120°F.) under desert conditions, and I found no change in the resistance during or after a period of a few weeks. These results satisfied me that the step of potting did not deteriorate the electrical connection regardless of which type

of connection it was that I used and that the shrinkage only added to the integrity of the joints.

The equipment used per my measurements was a Radio Shack battery source digital volt-ohm meter accurate to 1/10th of an ohm. Based upon these results, I am satisfied that I have demonstrated that it is possible to have a truly lead-free module with shelf and usage life equal or better than previous lead soldered assemblies.

The above-described embodiments of the present invention are merely descriptive of its principles and are not to be considered limiting. Although the above description has contemplated electronic modules powering LEDs or other lamps for shoes or other clothing, it will be apparent that the electrical module and connecting devices described above would also be effective for powering sound devices, either along or with a receiver responding to a remote transmitter, or other communication devices embedded in shoes or clothing. The scope of the present invention instead shall be determined from the scope of the following claims including their equivalents.

Where the claims herein refer to "spring clamps" or a "clamp member", it should be understood that such reference refers to any of crimped leads, clamped contacts, mechanical clamps, or a plug having a friction fit in a socket.